Geography of Food Distribution in the United States: Overview of ERS Research

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Presentation at interim meeting on NETS Regional Routing Model Project, Washington, D.C.

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Topics

- **What brings ERS to a NETS meeting on freight routing models?**
  - New ERS mandate
  - Overlapping interests in freight data
  - Mutual interests in analytical framework
- **How can ERS complement NETS and vice-versa**
  - Bottom-up and top-down data development
  - Knowledge collaboration platform
  - Exploration/development of analytical framework
- **Where do we go from here?**

Table 2—Market Value of Agricultural Products Sold, 2002

(farms/$1,000 sales)

Region	Grains- ... Oilseeds	Cotton	Crops total	Cattle ...	poultry	Live-stock total	Farm Total	sales < $1,000	...	$20,000 < sales < $24,999	...	Sales > $500,000
AL.000 AL.001 . . . AL.133												
. NY.000 .												
WY.000 WY.001 . . . WY.045												
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AL.001	+	+ + =		+	+ + =							
. . .												
AL.133	+	+ + =		+	+ + =							
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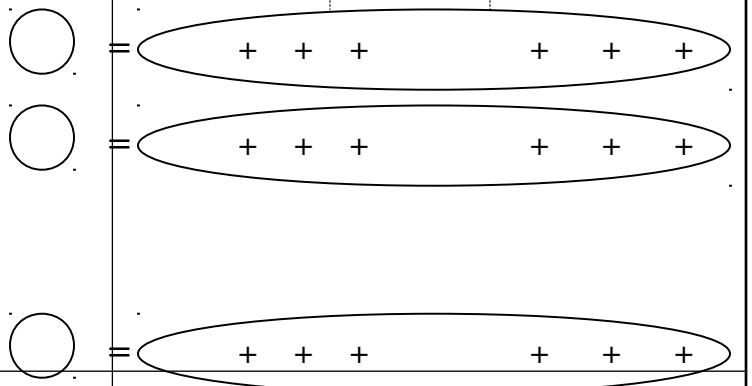
AL.000 AL.001 . . . AL.133										
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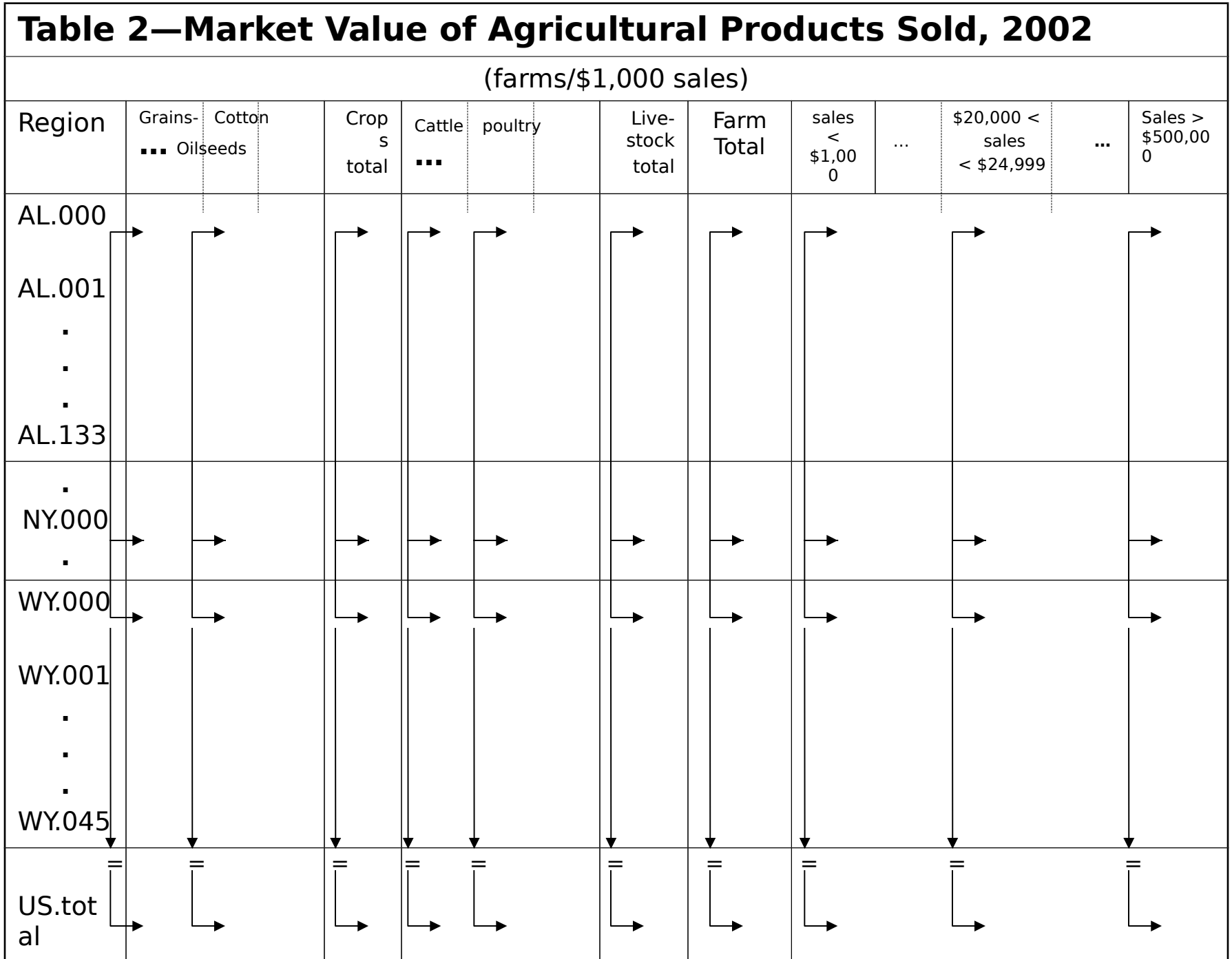


Filling data gaps and updates

- Multiple preliminary estimates
  - eg., estimate mean ($x_{i,r}$) and variance ($v_{i,r}$) of sales/farm and sales/acre (from other tables) by commodity from appropriate subset of published values
- WLS unconstrained data prior
- Quadratic penalty function
- A Knowledge Collaboration Platform

$$x_{i,r} = \sum_{\alpha \in (a,b,c)} w_\alpha x_{i,\alpha}$$

$$v_{i,r} = \sum_{\alpha \in (a,b,c)} w_\alpha^2 x_{i,\alpha}$$

$$w_i = \left[\frac{\left[\prod_\beta v_{\beta,r} \right]}{\left[\sum_I \left[\prod_\beta v_{\beta,r} \right] \right]} \right] \qquad \beta \in I, \beta \neq i$$

Mathematical programming model

```
rowsum(allrow,alltot).. v(allrow,alltot)+v1(allrow,alltot)
 =E= sum(allcol$col2tot(alltot,allcol),v(allrow,allcol) + v1(allrow,allcol));

colsum(s,gp).. v(s,gp) + v1(s,gp)
=E= sum(c$c2S(s,c),v(c,gp) + v1(c,gp));

colsum2(gp)..  v("99000",gp) + v1("99000",gp)
=E= sum(s,v(s,gp)+v1(s,gp));

link(allrow)..  v1(allrow,"C_sales") =E= v1(allrow,"sales");

suprise(allrow,allcol)..Diffv(allrow,allcol)$w(allrow,allcol)
=E=  v1(allrow,allcol) - v0(allrow,allcol);

OBJ1..  SS1 =E= 0.5*(sum((allrow,allcol)$w(allrow,allcol),
Diffv(allrow,allcol)*Diffv(allrow,allcol)/w(allrow,allcol)));
```

A Knowledge Collaboration Platform

Annual Sales
$ million

Select commodity:

- grains
- Tobacco
- .
- .
- cattle
- poultry
- .
- .

Select geography:

- .
- .
- New Castle, DE
- Kent,DE
- Sussex, DE
- .
- .

Profile of product sales

Mean value:

Variance:

Upper bound:

Lower bound:

Update Information

Mean value:

Variance:

Upper bound:

Lower bound:

Description of update:

☆ = user defined query

more updates

run program

Figure 1--Multiregional SAM: a two-region (I & II), two-sector (a & b) closed economy

		I a	I b	II a	II b	Final demand	Total sales
I	a	5.0	7.5	10.8		3.0	26.3
	b	5.0	5.0		11.	19.5	41.4
II	a	7.9		4.0	8.5	3.0	23.4
	b		15.7	2.0	5.0	13.5	36.2
Value added		10.0	12.5	5.0	11.5		
Total supply		27.9	40.7	21.8	36.9		

Constrained matrix balancing

Balanced MR-SAM

Best general unbiased estimates of interregional trade

Figure 2--Published and unpublished commodi survey data with corresponding CVs

Informed data priors of model variables:

Commodity	From region:	To region: 1	2	Total	Coefficient of variation (CV) 1	2	Total
		$ millions			$ millions		
a	1	10.0	10.8	20.0	36.2	23.2	1.1
b	1	10.4	11.9	22.0	27.6	22.6	0.3
subtotal	1	20.0	25.0	42.0	1.8	1.9	0.3
a	2	7.9	6.1	14.0	18.5	2.7	1.3
b	2	14.4	11.3	25.0	55.0	21.1	2.4
subtotal	2	22.0	13.0	39.0	1.7	0.9	0.8
column total		42.0	38.0	81.0	0.1	0.9	NA

$\hat{T}$ V

$$1)\ \text{MinL}(\tilde{T},\lambda) = (\tilde{T} - \hat{T})' V^{-1} (\tilde{T} - \hat{T}) + \lambda' G\tilde{T}$$

Figure 3--Estimated interregional trade ma based on survey of commodity flows

		I a	I b	II a	II b
I	a	9.5		10.8	
	b		9.8		11.
II	a	7.9		5.7	
	b		15.7		8.3

Impedance based assignments of energy and freight service costs:

- In the U.S. account, all sectors have a know freight service cost, by mode, for each intersectoral transaction
- For energy and labor, this total will be assigned to each O-D transaction using an impedance based algorithm.
- For other administrative freight services, costs will be shared out proportional to payload.

Splitting the energy and labor freight serv

md_text	C1	C2	C3	C4	C5	C6	C7	HHS	INV	GOV	EXP
Energy	1.25	0.1	0.15	1.2	0.12	0.1	0.3	1.292	0.100	0.388	0.000
Farm	0.1	0.39	1.1	0.05	0.01	0	0	0.300	0.000	0.000	0.250
Food	0	0	0.3	1.75	0	0	2.5	1.300	0.000	0.000	0.050
Other	0.8	0.44	1	20	0.9	2.42	0.33	22.833	7.604	18.795	7.500
Trans	0.25	0.02	0.05	1	0.02	0.1	0.12	0.290	0.050	0.150	0.050
Trade	0	0.05	0.03	1	0	0	0	1.292	0.323	1.433	0.872
Grocery	0	0	0	0	0	0	0	5.000	0.000	1.000	0.000
Labor	0.5	0.4	0.67	30	0.5	1.25	1.5				
Capital	2	0.4	1.1	8.66	0.33	0.83	1				
Taxes	0.1	0.2	0.6	10	0.12	0.3	0.25				
Imports	0.000	0.200	0.900	8.962	0.100	0.000	0.000				

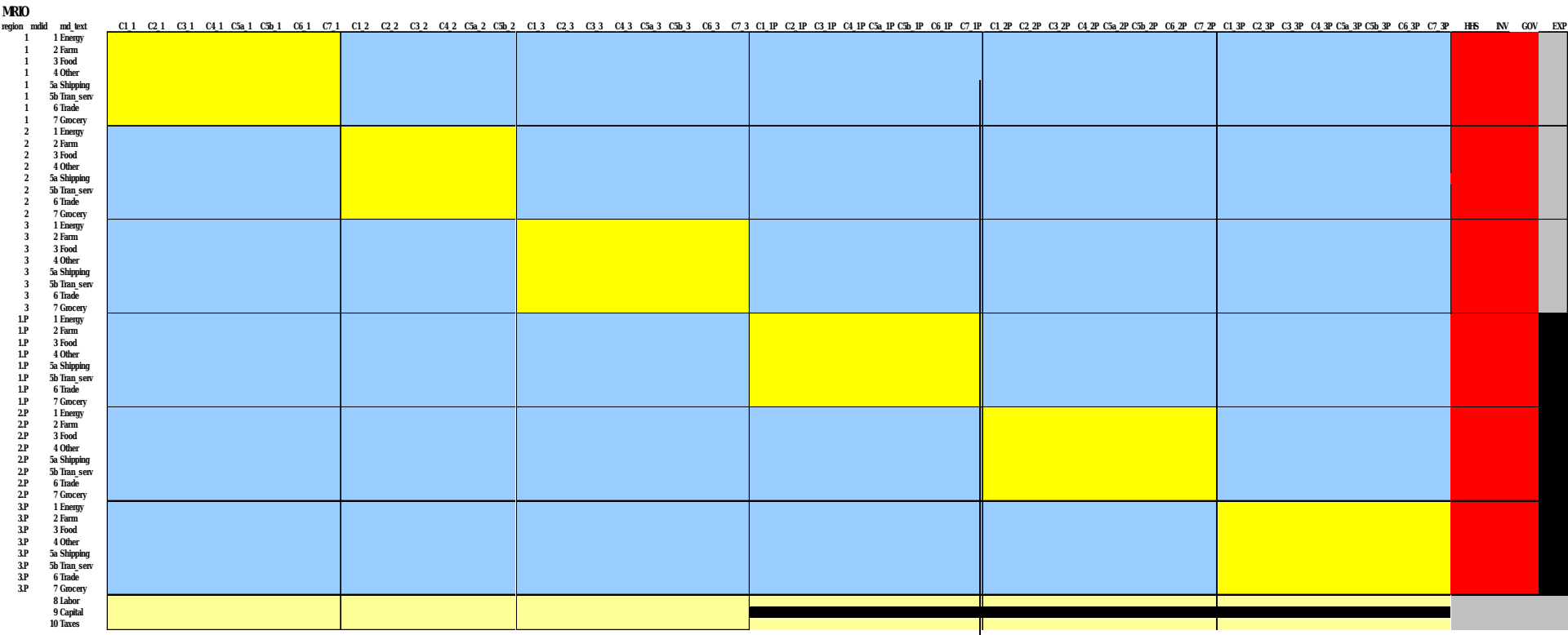
md_text	C1	C2	C3	C4	C5a	C5b	C6	C7	HHS	INV	GOV	EXP
Energy	1.25	0.1	0.15	1.2	0.108	0.012	0.1	0.3	1.292	0.100	0.388	0.000
Farm	0.1	0.39	1.1	0.05	0	0.01	0	0	0.300	0.000	0.000	0.250
Food	0	0	0.3	1.75	0	0	0	2.5	1.300	0.000	0.000	0.050
Other	0.8	0.44	1	20	0	0.9	2.42	0.33	22.833	7.604	18.795	7.500
Shipping	0.007	0.006	0.015	0.110	0.000	0.005	0.013	0.007	0.137	0.041	0.101	0.041
Tran_serv	0.243	0.014	0.035	0.890	0	0.015	0.087	0.113	0.153	0.009	0.049	0.009
Trade	0	0.05	0.03	1	0	0	0	0	1.292	0.323	1.433	0.872
Grocery	0	0	0	0	0	0	0	0	5.000	0.000	1.000	0.000
Labor	0.5	0.4	0.67	30	0.375	0.125	1.25	1.5				
Capital	2	0.4	1.1	8.66	0	0.33	0.83	1				
Taxes	0.1	0.2	0.6	10	0	0.12	0.3	0.25				
Imports	0.000	0.200	0.900	8.962	0.000	0.100	0.000	0.000				

A Three Region, Eight Sector MRIO

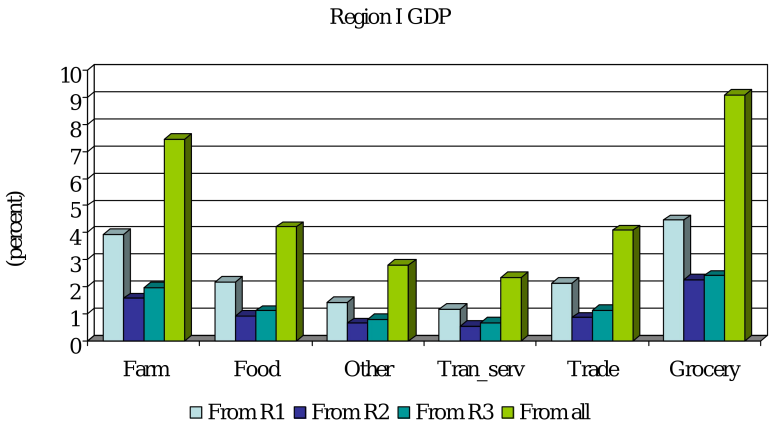
MRIO

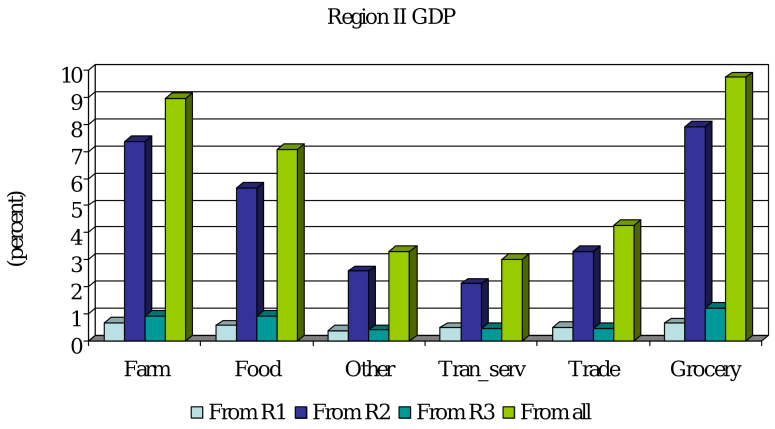
region	mdid	md_text	C1_1	C2_1	C3_1	C4_1	C5a_1	C5b_1	C6_1	C7_1	C1_2	C2_2	C3_2	C4_2	C5a_2	C5b_2	C6_2	C1_3	C2_3	C3_3	C4_3	C5a_3	C5b_3	C6_3	C7_3	HHS	INV	GOV	EXP
1	1	Energy	0.313	0.022	0.027	0.660	0.036	0.004	0.035	0.100	0.065							0.005								0.450	0.044	0.190	0.000
1	2	Farm	0.025	0.086	0.198	0.028	0.000	0.003	0.000	0.000		0.012							0.111							0.093	0.000	0.000	0.054
1	3	Food	0.000	0.000	0.054	0.963	0.000	0.000	0.000	0.835			0.025							0.029						0.406	0.000	0.000	0.009
1	4	Other	0.200	0.097	0.180	11.000	0.000	0.301	0.835	0.110				6.207							9.519					6.731	3.335	8.969	3.943
1	5a	Shipping	0.002	0.001	0.002	0.050	0.000	0.001	0.004	0.002					0.034							0.073				0.031	0.014	0.038	0.017
1	5b	Tran_se	0.061	0.003	0.006	0.490	0.000	0.005	0.030	0.038						0.148							0.192			0.046	0.004	0.023	0.004
1	6	Trade	0.000	0.011	0.005	0.550	0.000	0.000	0.000	0.000							0.062							0.150		0.397	0.142	0.706	0.307
1	7	Grocery	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000															0.000	1.670	0.000	0.334	0.000
2	1	Energy	0.261								0.500	0.031	0.062	0.204	0.036	0.004	0.032	0.451								0.342	0.025	0.079	0.000
2	2	Farm		0.024							0.040	0.121	0.451	0.009	0.000	0.003	0.000		0.025							0.083	0.000	0.000	0.080
2	3	Food			0.588						0.000	0.000	0.123	0.298	0.000	0.000	0.000			0.394						0.361	0.000	0.000	0.020
2	4	Other				0.265					0.320	0.136	0.410	3.400	0.000	0.300	0.772				1.081					6.559	1.885	3.714	1.311
2	5a	Shipping					0.054				0.003	0.002	0.006	0.018	0.000	0.002	0.004					0.073				0.034	0.009	0.018	0.007
2	5b	Tran_serv						0.222			0.097	0.004	0.014	0.151	0.000	0.005	0.028						0.160			0.044	0.002	0.010	0.002
2	6	Trade							0.483		0.000	0.016	0.012	0.170	0.000	0.000	0.000							0.268		0.362	0.080	0.300	0.273
2	7	Grocery								0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000								0.000	1.665	0.000	0.333	0.000
3	1	Energy	0.441								0.059							0.438	0.047	0.062	0.336	0.036	0.004	0.034	0.100	0.500	0.031	0.118	0.000
3	2	Farm		0.001								0.149						0.035	0.183	0.451	0.014	0.000	0.003	0.000	0.000	0.124	0.000	0.000	0.116
3	3	Food			0.331								0.542					0.000	0.000	0.123	0.490	0.000	0.000	0.000	0.833	0.533	0.000	0.000	0.021
3	4	Other				2.100								1.114				0.280	0.207	0.410	5.600	0.000	0.300	0.813	0.110	9.543	2.383	6.112	2.246
3	5a	Shipping					0.054								0.034			0.003	0.003	0.007	0.042	0.000	0.002	0.006	0.002	0.072	0.017	0.045	0.017
3	5b	Tran_serv						0.222								0.124		0.085	0.007	0.014	0.249	0.000	0.005	0.029	0.038	0.064	0.003	0.016	0.003
3	6	Trade							0.122								0.308	0.000	0.024	0.012	0.280	0.000	0.000	0.000	0.000	0.533	0.101	0.427	0.291
3	7	Grocery								0.000								0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.665	0.000	0.333	0.000
	8	Labor	0.125	0.088	0.121	16.500	0.125	0.042	0.431	0.501	0.200	0.124	0.275	5.100	0.125	0.042	0.399	0.175	0.188	0.275	8.400	0.125	0.042	0.420	0.500				70.872
	9	Capital	0.500	0.088	0.198	4.763	0.000	0.110	0.286	0.334	0.800	0.124	0.451	1.472	0.000	0.110	0.265	0.700	0.188	0.451	2.425	0.000	0.110	0.279	0.333				
	10	Taxes	0.024	0.044	0.108	5.505	0.000	0.040	0.105	0.083	0.042	0.062	0.246	1.713	0.000	0.040	0.096	0.034	0.094	0.245	2.782	0.000	0.040	0.099	0.083				
	11	Imports	0.000	0.145	0.501	8.553	0.000	0.100	0.000	0.000	0.000	0.053	0.000	0.409	0.000	0.000	0.000	0.000	0.001	0.399	0.000	0.000	0.000	0.000	0.000	70.872			

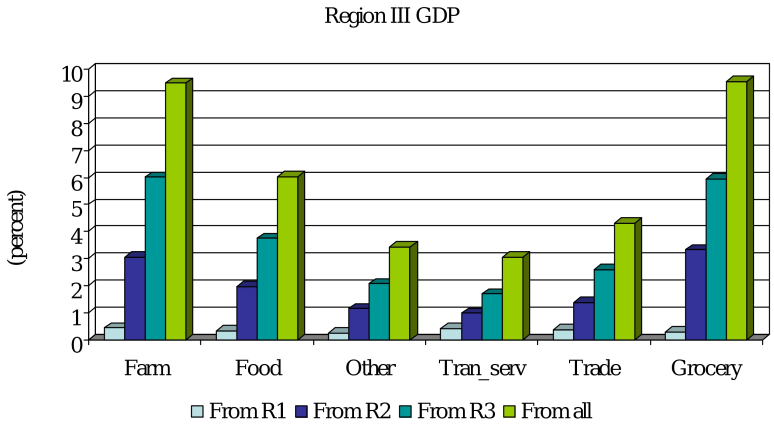
Creation of State-based port districts



Total Energy Requirement as a Percentage of GDP







DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, INSTITUTE FOR WATER RESOURCES
7701 TELEGRAPH ROAD, CASEY BLDG.
ALEXANDRIA, VA 22315-3868

REPLY TO ATTENTION OF:

MEMORANDUM OF UNDERSTANDING
BETWEEN
THE UNITED STATES ARMY CORPS OF ENGINEERS
INSTITUTE FOR WATER RESOURCES
AND
THE UNITED STATES DEPARTMENT OF AGRICULTURE
ECONOMIC RESEARCH SERVICE

ARTICLE I - PARTIES

A. The Institute for Water Resources (IWR) and the Economic Research Service (ERS), jointly referred to herein as "Parties", agree to establish this memorandum of understanding (MOU) to address joint data and economic analysis of the issues affecting the movement of Agricultural Commodities in the United States.

This MOU is entered into by the authority of the Agricultural Adjustment Act of 1938 (7 U.S.C. § 1292 (c)) and the Agricultural Marketing Act of 1946 (7 U.S.C. § 1622).

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Where do we go from here?

- Build out and update freight data and modeling framework?
- Expand networks for collaboratio